TUSKEGEE UNIVERSITY

Research and Education Overview

Presented by

Shaik Jeelani, Ph.D., P.E., Fellow ASME
Vice President for Research and Dean of Graduate Studies
&
Heshmat Aglan, Ph.D., P.E.
Dean, College of Engineering
at
Tuskegee University

NASA Road Infusion Tour
UNLV

January 10, 2017

TUSKEGEE UNIVERSITY

History

- The Institution was founded as **Normal School** in 1881 by it's first President Booker T. Washington.
- It was renamed **Tuskegee Institute** in 1937.
- It was named **Tuskegee University** in 1986 by it's fifth President Dr. Benjamin Patton.
- The University's Third President, Dr. Frederick Patterson founded the United **Negro College Fund** in 1944.
- Tuskegee University was the first Black College to be designated as a Registered **National historic Landmark** in1966.
- Tuskegee University is the only college to be designated a **National historic Site** in 1974.
- **First Master's Degree Program** in Agriculture, Education and Home Economics was offered in 1944.
- **First Ph.D. program** in Materials Science & Engineering offered in 1998.

TUSKEGEE UNIVERSITY

Points of Distinction

- **The university is the largest producer of African-Americans with baccalaureate degrees in math, science and engineering in Alabama.**
- **Tuskegee's Materials Science and Engineering Program graduates the largest number of black PhD students in the U.S.**
- **Tuskegee University is the No. 1 producer of African-American aerospace science engineers in the nation**.
- Tuskegee University is the only HBCU with a fully accredited College of Veterinary Medicine that produces over **75 percent of the African-American Veterinarians**.
- Tuskegee is the only college or university campus in the nation to be designated a National Historic Site by the U.S. Congress.
- More U.S. presidents have visited Tuskegee University than any other historically black college or university.
- The Tuskegee Airman, who trained at the Tuskegee Air Field in July 1941, were the first African-American fighter pilots in the U.S. Army Air Corps.
- The ROTC program at Tuskegee has produced more African-American general officers in the military than any other institution, including the service academies.
- Tuskegee University is the leading producer in the country of African-American engineering graduates in chemical, electrical and mechanical engineering.
- Tuskegee University is the only HBCU in the nation designated as the location for National Center for Bioethics in Research and Health Care.
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TUSKEGEE UNIVERSITY

Colleges and Schools

Andrew F. Brimmer College of Business & Information Science

College of Agriculture, Environment & Nutrition Science

College of Arts & Science

College of Engineering

College of Veterinary Medicine,

Robert R. Taylor School of Architecture & Construction Science

School of Education

School of Nursing and Allied Health

TUSKEGEE UNIVERSITY

Graduate Degrees

Doctor of Philosophy

- Integrative Biosciences
- Integrative Public Policy & Development
- Interdisciplinary Pathobiology
- Materials Science & Engineering

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Graduate Degrees (Cont'd.)

Master of Science

- Agricultural & Resource Economics
- Animal Sciences
- Biology
- Chemical Engineering
- Chemistry
- Electrical Engineering
- Environmental Science
- Food & Nutritional Science
- Information Systems & Security Management
- Materials Science & Engineering
- Master in Public Health & Public Health
- Mechanical Engineering
- Occupational Therapy
- Plant & Soil Sciences
- Veterinary Sciences (NOT DVM)

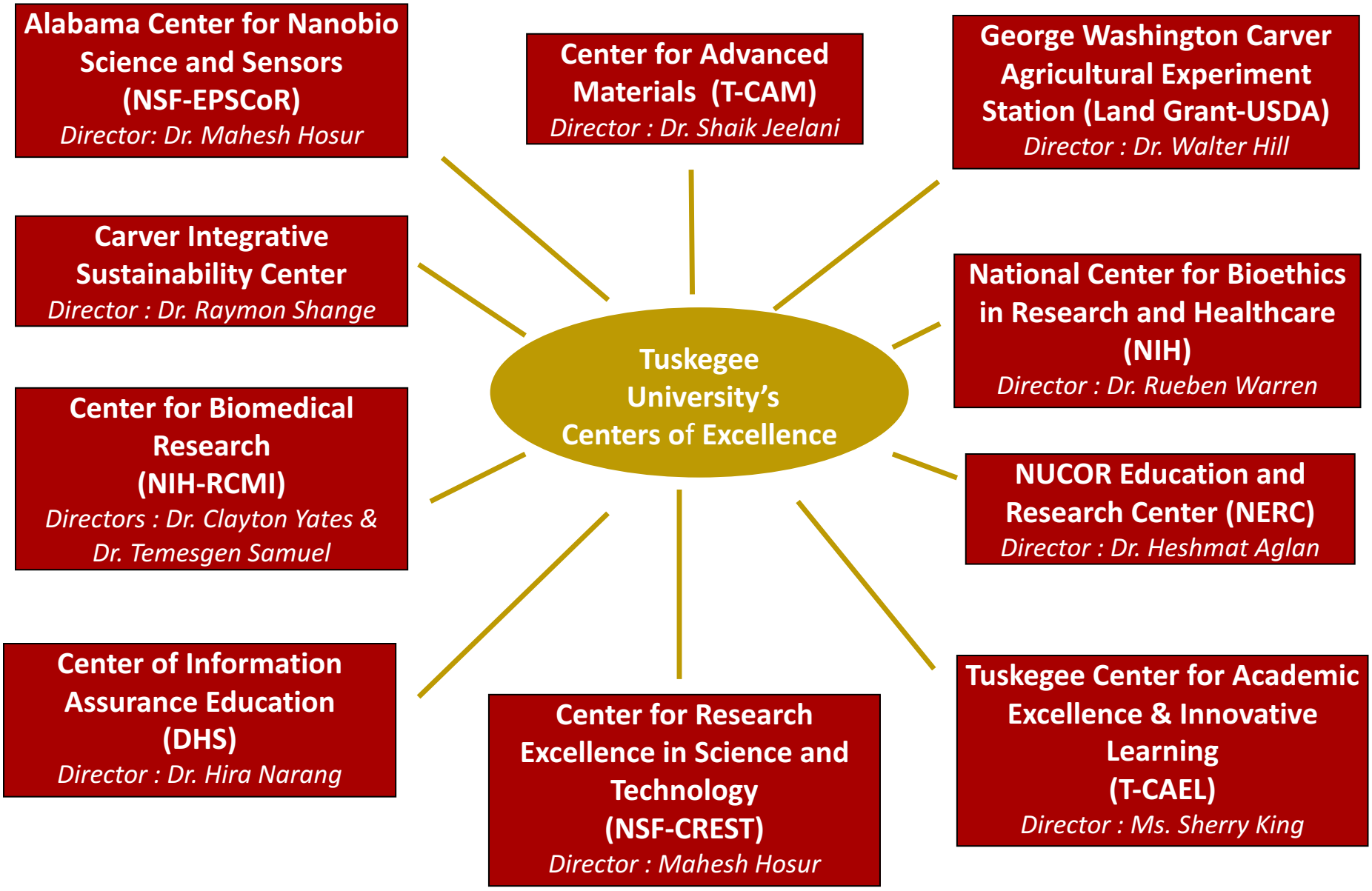
Online Degrees

- Environmental Management
- Environmental Science
- Information Systems & Security Management

TUSKEGEE UNIVERSITY

Research Expertise

- Additive Manufacturing
- Animal and Poultry Sciences
- Biological and Biomedical Sciences
- Food and Nutrition Sciences
- Computer Science and Information Security
- Energy Generation, Storage and Transportation
- Environmental, Natural Resources and Plant Sciences
- Materials Science and Engineering
- NanoBioTechnology
- Semiconductors and Microelectronics
- Veterinary Medicine


Alabama Center for Nanobio Science and Sensors (NSF-EPSCoR)
Director: Dr. Mahesh Hosur
Center for Advanced Materials (T-CAM)
Director : Dr. Shaik Jeelani
George Washington Carver Agricultural Experiment Station (Land Grant-USDA)
Director : Dr. Walter Hill
Carver Integrative Sustainability Center
Director : Dr. Raymon Shange
Tuskegee University's Centers of Excellence
National Center for Bioethics in Research and Healthcare (NIH)
Director : Dr. Rueben Warren
Center for Biomedical Research (NIH-RCMI)
Directors : Dr. Clayton Yates & Dr. Temesgen Samuel
NUCOR Education and Research Center (NERC)
Director : Dr. Heshmat Aglan
Center of Information Assurance Education (DHS)
Director : Dr. Hira Narang
Center for Research Excellence in Science and Technology (NSF-CREST)
Director : Mahesh Hosur
Tuskegee Center for Academic Excellence & Innovative Learning (T-CAEL)
Director : Ms. Sherry King

TUSKEGEE UNIVERSITY

Funding Agencies

- National Aeronautics and Space Administration (NASA)
- National Science Foundation (NSF)
- Smithsonian Institute
- U.S. Department of Defense (DOD: Airforce, Army, Navy)
- U.S. Department of Homeland Security (DHS)
- U.S. Department of Energy (DOE)Humanities (NEH)
- National Endowment for
- U.S. Department of Agriculture (USDA)
- U.S. Department of Education (DOEd)
- U.S. Department of Health and Human Services (HHS)
- U.S. Department of Interior(DOI)
- U.S. Department of Transportation (DOT)
- State of Alabama
- Industry

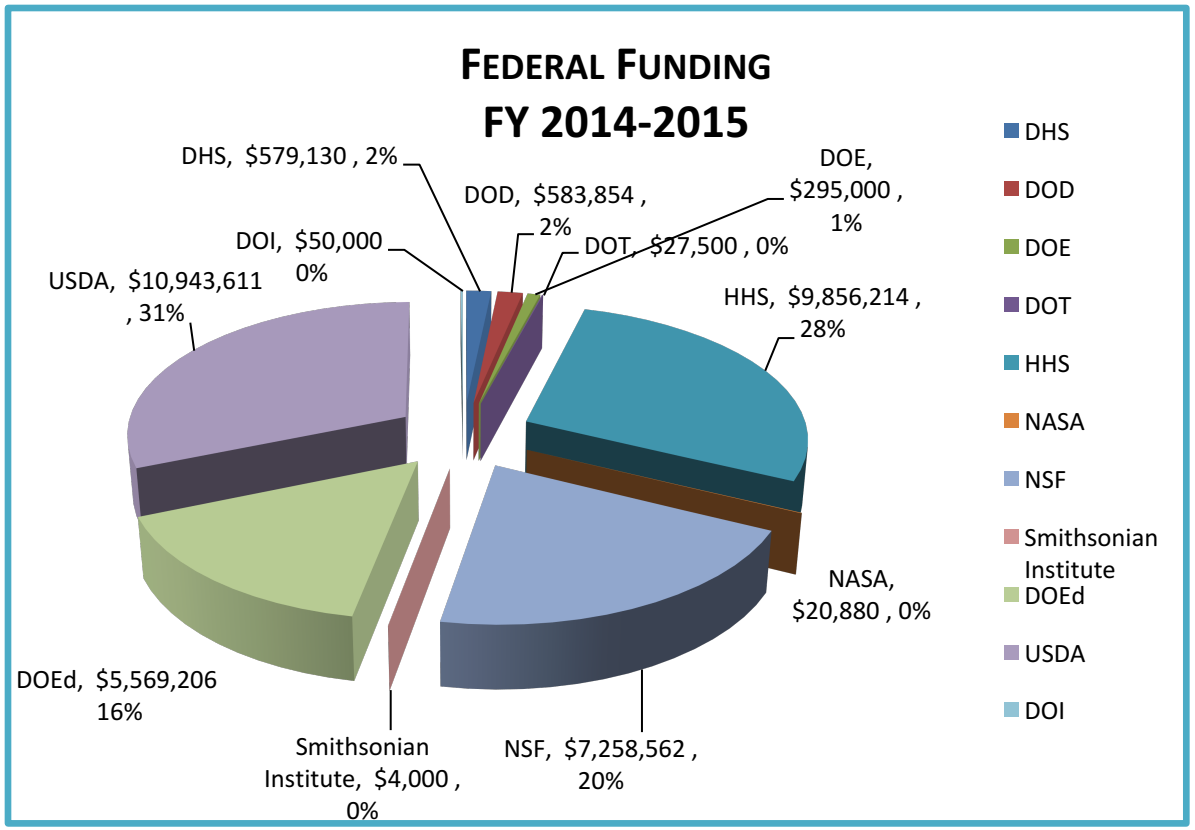
TUSKEGEE UNIVERSITY

2014-2015 Funding by Colleges and Other Units

ACADEMIC AREAS/CENTERS/OTHER MAJOR UNITS	NO. OF AWARDS	DOLLAR AMOUNT
College of Agriculture, Environmental and Nutrition Sciences (CAENS)	77	**$15,359,131**
College of Arts and Sciences (CAS)	13	**$2,705,609**
College of Business and Information Science (CBIS)	7	**$250,663**
College of Engineering (CE)	50	**$10,106,322**
College of Veterinary Medicine, Nursing and Allied Health (CVMNAH)	23	**$11,316,282**
School of Architecture (SOA)	2	**$12,000**
School of Education (SED)	0	**$0**
Bioethics Center	5	**$296,471**
Center for Biomedical Research (CBR)/RCMI	1	**$763,121**
International Programs	2	**$48,744**
Health Disparities Institute for Research & Education (HDIRE)	0	**$0.00**
President's Office	3	**$3,032,125**
Provost (Library)	3	**$90,000**
Student Affairs	1	**$383,897**
TOTAL	**187**	**$44,364,365**

TUSKEGEE UNIVERSITY

2014-2015 Funding by Agencies



TUSKEGEE UNIVERSITY

Compliance Committees

- Animal Care and Use Committee (IACUC)
- Biosafety Committee
- Intellectual Property Committee (IP)
- Institution Review Board (IRB)
- Radiation Safety Committee
- Policy to Respond to Scientific Misconduct

Core Strengths and Capabilities - *College of Engineering*

Aerospace: experimental aerodynamics, vortex-dominated flows, flight simulation, configuration aerodynamics, human interface.

***Chemical*:** microfluidics, corrosion, carbon capture, bio-fuels, adsorption, water & wastewater treatment, smart manufacturing, bio-chemical engineering, chemical process modeling.

Electrical: electronic warfare and technology; systems engineering; control systems, wireless sensors and data gathering networks, information assurance; integrated circuits; cyber; power/energy.

Mechanical: fracture and fatigue evaluation, additive manufacturing, proton and ion conductive membranes, corrosion and coatings, environmental aging of materials, dislocation dynamics in materials, fuel cells.

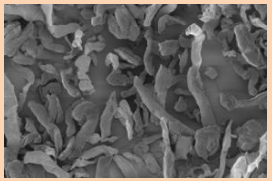
Materials Science & Engineering: synthesis and chemical analysis of materials, processing of bio materials, performance and nondestructive evaluation, and modeling.

- **Number of students: *~600 undergraduate and ~40 graduate***
- **Number of Faculty and Staff: 36 and 10**
- **Number of graduates ~ 100**
- **Annual Research Awards: ~ $ 10 M**
- **Refereed Publications ~ 50/ year**

Research Capability: Materials Science and Engineering

Bio-Nanocomposites Research

Biomass



Extraction and deconstruction of cellulose for production of biorenewal chemicals and plastics

Development of gradient based films for removal of CO_2 and H_2S from Shale gas.

3-D Membranes

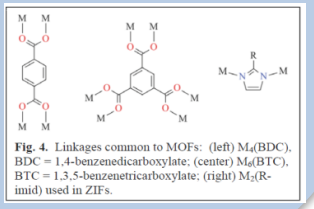


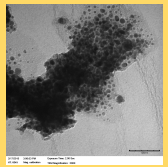
Fig. 4. Linkages common to MOFs: (left) M_4(BDC), BDC = 1,4-benzenedicarboxylate; (center) M_6(BTC), BTC = 1,3,5-benzenetricarboxylate; (right) M_2(R-imid) used in ZIFs.

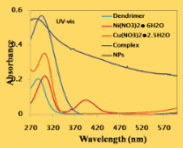
Sustainable materials and processes for nano-enabled technologies

Outcome

Benign by

Nanoparticles



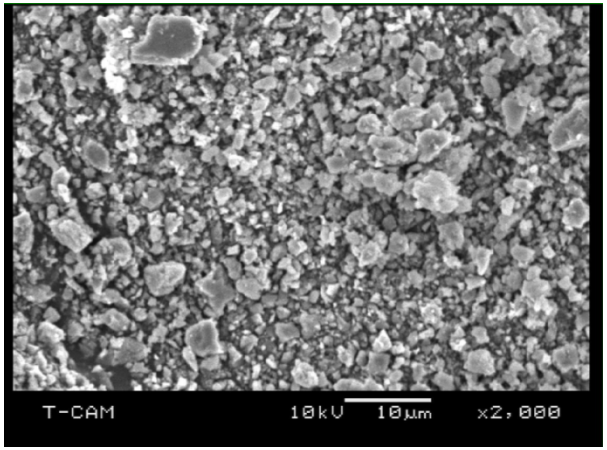


Synthesis and characterization of mono- and multimetal nanoparticles

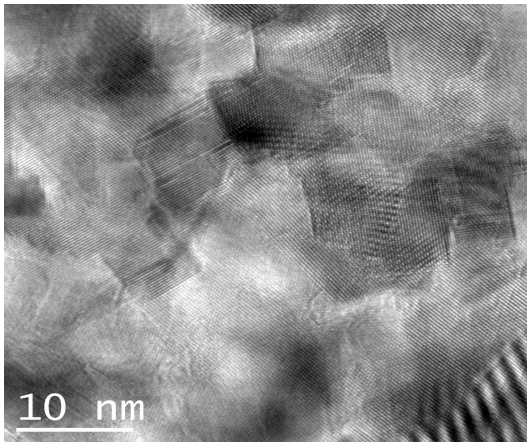
Eggshell Nanoparticle Synthesis

Eggs shells, which end up as waste materials are used in our research to synthesize calcium carbonate nanoparticles. These nanoparticles are further used to strengthen polymers, pre-cursors to synthesize other nanoparticles for several medical, pharmaceutical, and structural applications. In this work, we collaborate with researchers from other colleges in the university and other universities.

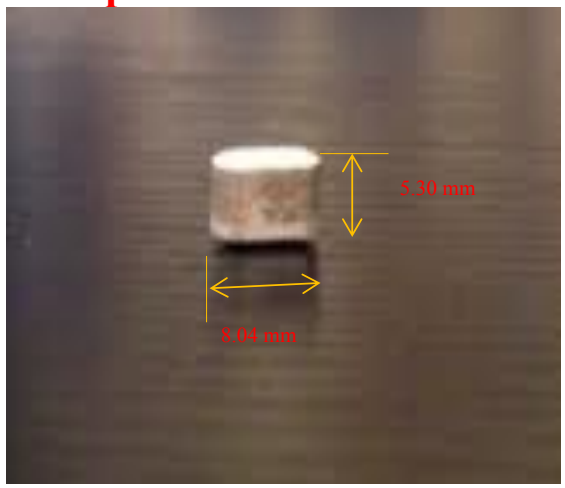
Ground eggshells



Synthesized $CaCO_3$ particles



Nanoparticle based drug delivery tablet developed for cancer treatment



Nanostructured Thin Films and Coatings

NANOSTRUCTURED THERMOPLASTIC POLYIMIDE FILMS

Date of Patent: May 19, 2015

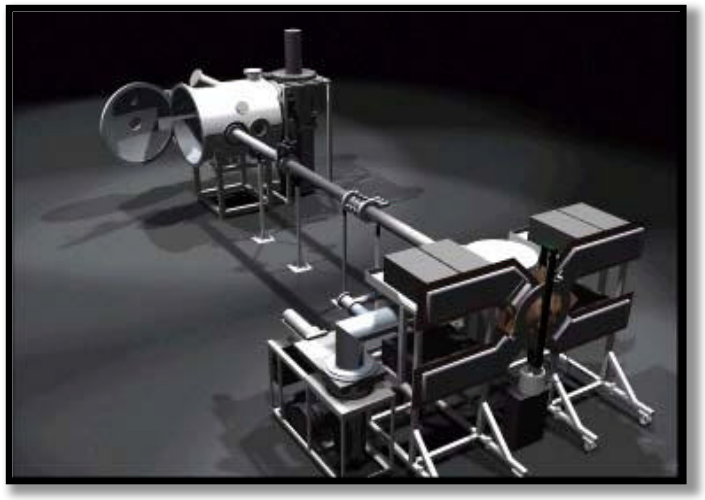
Assignee: Tuskegee University

Proton Conductive Membrane

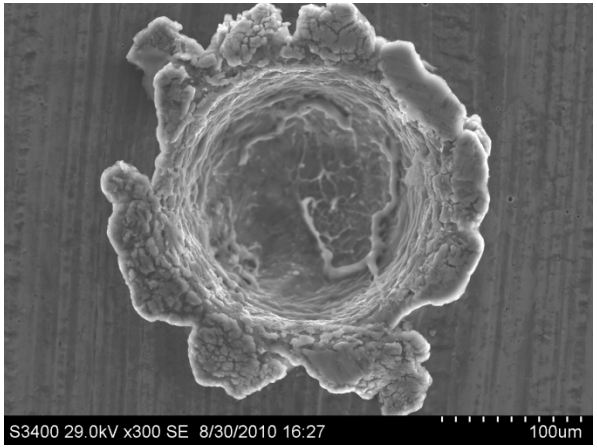
Aluminum substrates without and with nanostructured coatings

Steel substrates without and with nanostructured coatings

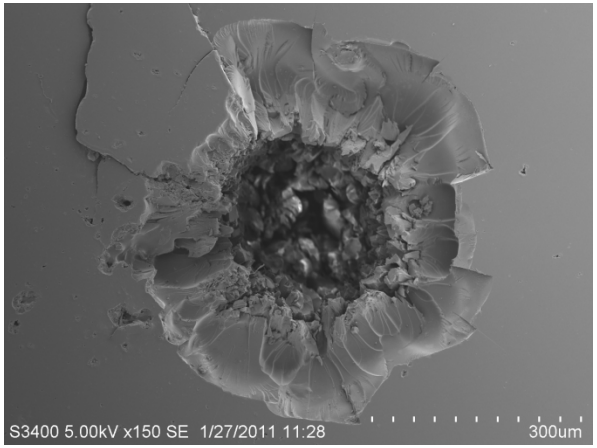
Hypervelocity Impact Analysis of Space Materials



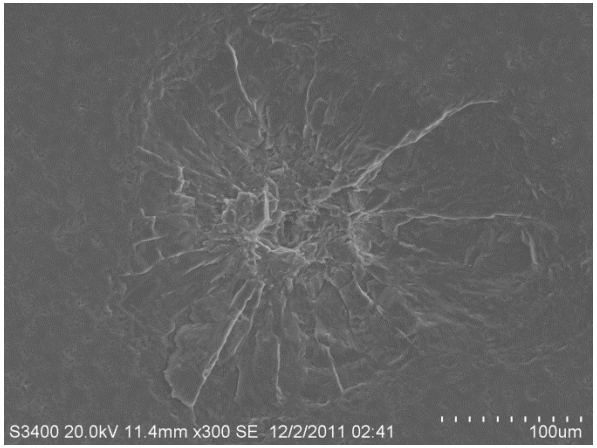
Plasma Drag Hypervelocity Particle Accelerator



Aluminum Alloy



Phenolic Resin



Silicon Carbide

Funded by MDA

Railroad Rail Head Repair

Railroad rail head repair

Date of Patent: June 17, 2016

Patent No. US 20140166766 A1

Assignee: Tuskegee University

ABSTRACT

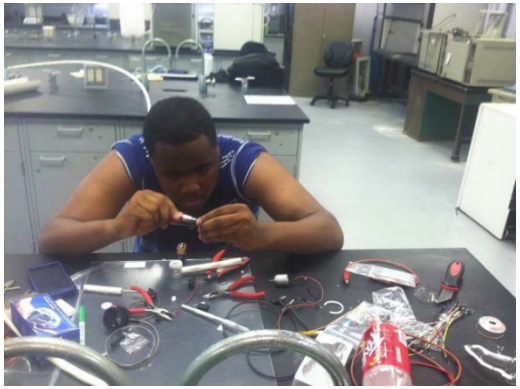
A multi-pass gas metal arc weld ("GMAW") approach is used for in-situ repair of railhead defects. A defect is removed via machining a perpendicular slot or grove in the railhead leaving the web and base unaltered. A sufficient number of GMAW passes are used to fill the slot using a weld material suitable for the particular type of parent steel, and excess weldment can be removed. Optionally, for pearlitic steel rails post-weld heat treatment can be used to cause austenization and/or quenching of the weld. The weld heat inputs and other parameters are controlled to avoid ductile and brittle fracture related morphologies.

Education, Outreach, and Student Success

Middle school students hands-on activities

Teacher training activities

Dr. Kristy Crews (2016 graduate)with mentor Dr. Curry



REU student Demetrius Findley

Summer FASTREC student activities

International Collaborations

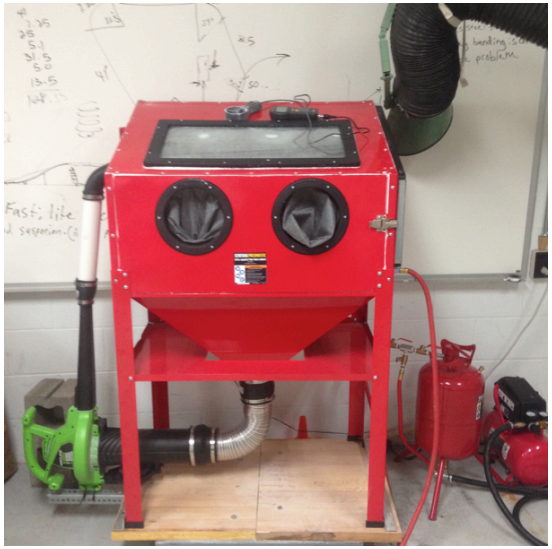
Research Capability: Mechanical Engineering

Testing and Evaluation of Materials and Components under Combined Environmental Conditions

Environmental conditions:

- ASTM B117 SALT SPRAY TESTING (Salt fog testing)
- ASTM G85:A4 SALT/SO_2 FOG (Spray testing)
- Sand cloud exposure
- UV aging

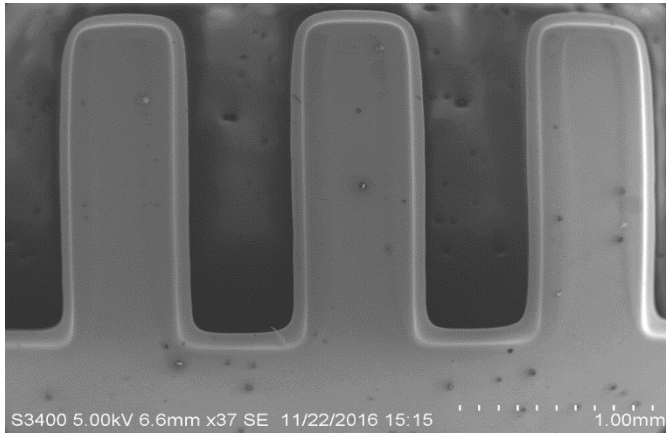
A combination of the above tests

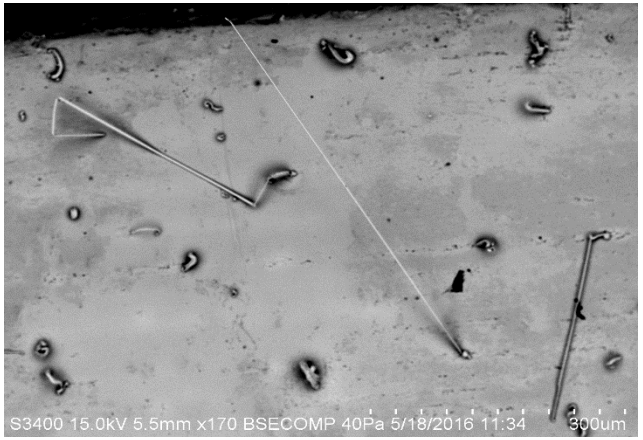


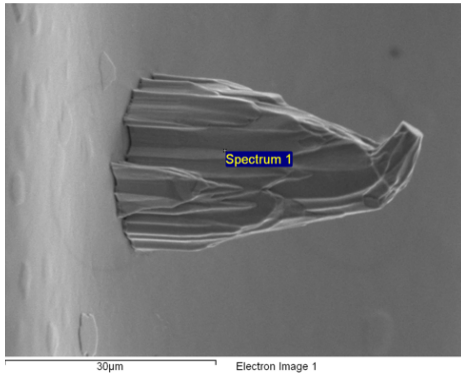
Funded by Raytheon

Tin Whisker Growth under Hygrothermal and/or Corrosive Environment Exposure

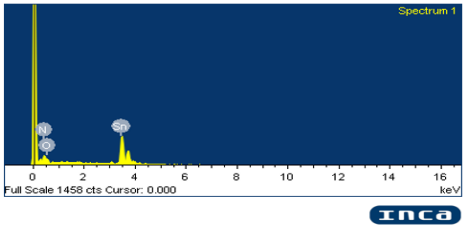
Test Chamber

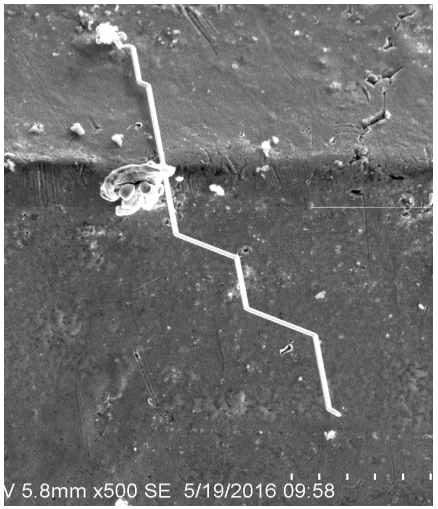






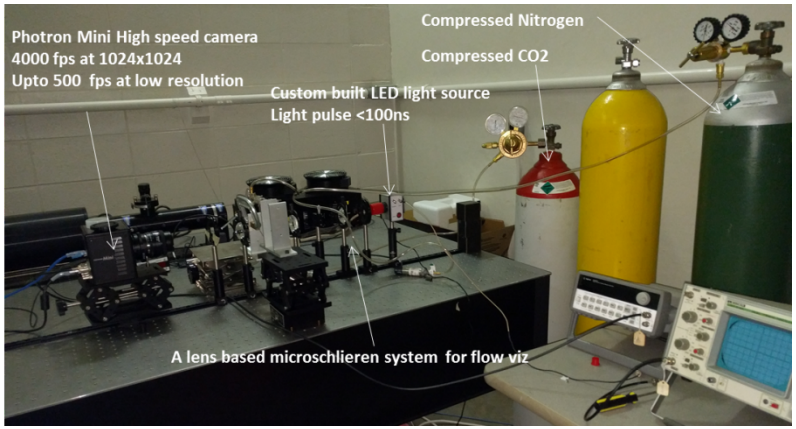
Element	Weight%	Atomic%	Compd%	Formula
N K	0.42	1.44	1.61	N2O5
Sn L	77.50	31.65	98.39	SnO2
O	22.08	66.91		
Totals	100.00			



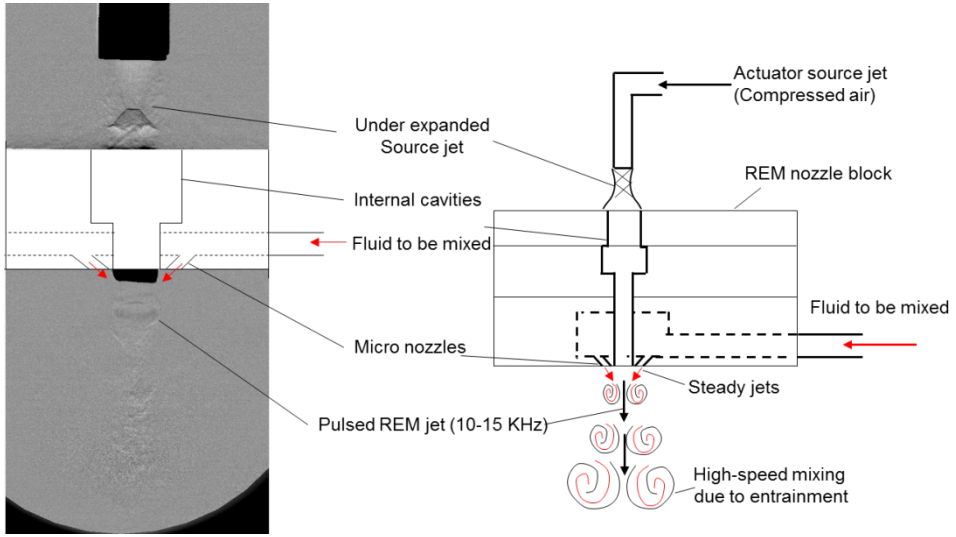


Funded by The Boeing Company

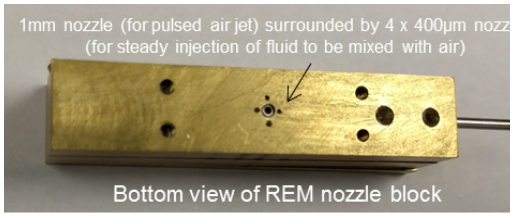
Super Sonic Flow Mixing Using Ultrasonic Microactuators



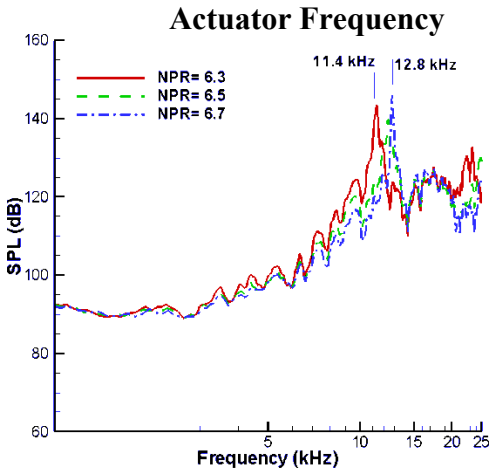
High speed flow diagnostic lab

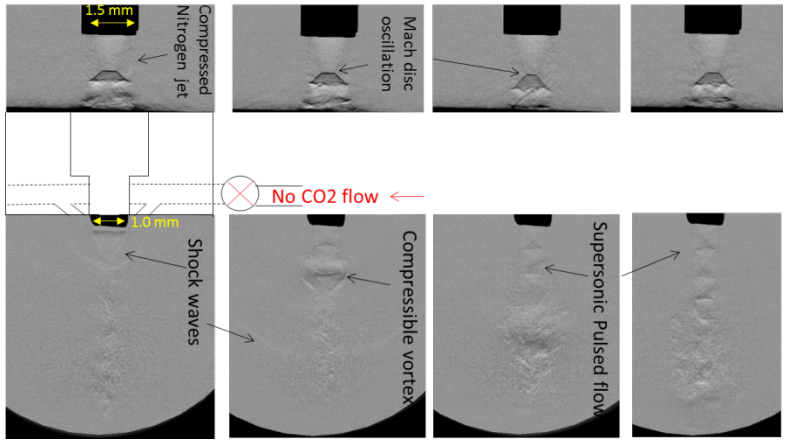


Proposed idea for high speed mixing



Nozzle –Model integrated with actuators





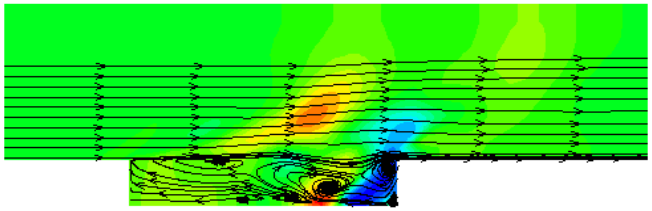
Flowfield

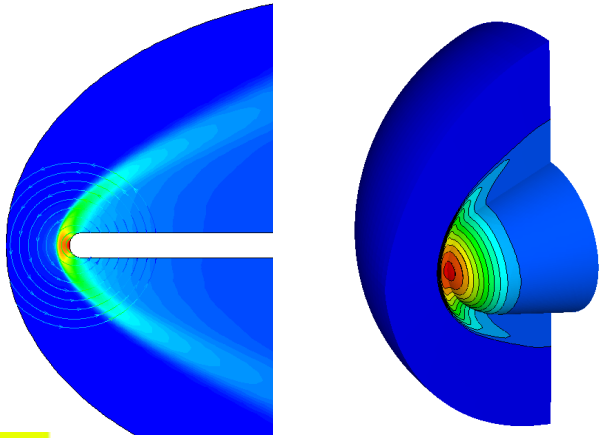
Supported by National Science Foundation: PI Dr. John Solomon, Mechanical engineering

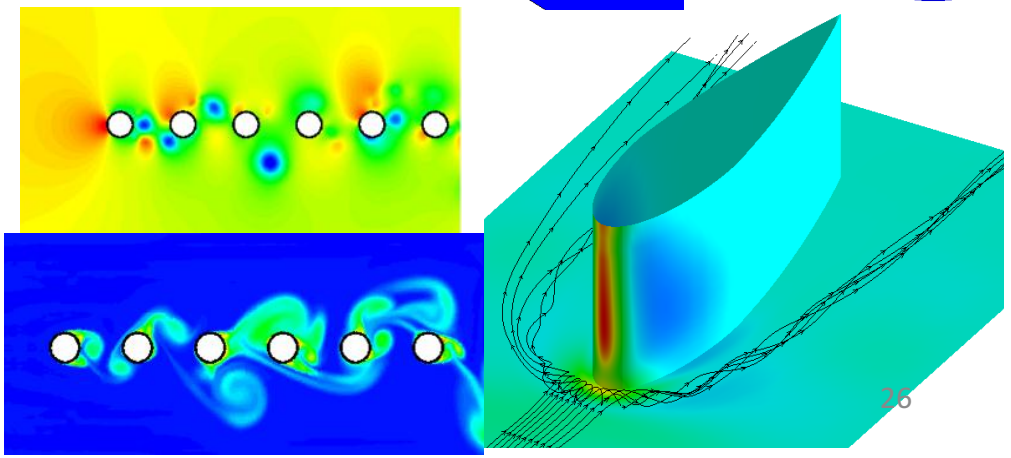
Research Capability: Aerospace Science Engineering

Highly Efficient High Fidelity Computational Schemes

- **High-fidelity computational analysis of hypersonic and supersonic flow fields**
  - **Implementation of high-resolution numerical schemes for modeling shock/boundary layer interaction phenomenon**
    - ✧ Total Variation Diminishing (TVD)
    - ✧ Weighted Essentially Non-Oscillatory (WENO)
    - ✧ Direct Numerical Simulation (DNS) of turbulent supersonic cavity flow
  - **Magneto-hydrodynamics(MHD) hypersonic/supersonic flows**
    - ✧ Navier-Stokes and Ampere-Maxwell equations
    - ✧ Approximate formulation
    - ✧ Multi-block solver
  - **Tip-leakage flow of surface-mounted obstacles**
  - **Heat transfer analysis**
- **Resources**
  - **Self-developed computer codes**
    - ✧ FORTRAN, MATLAB
  - **Commercial grid generators**
    - ✧ Gridgen, Gambit
  - **High Performance Computing**
    - ✧ Alabama Supercomputing Authority

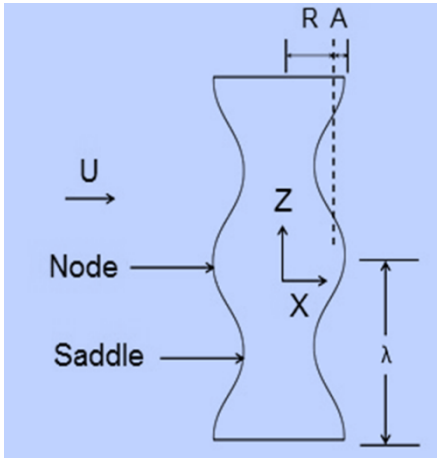


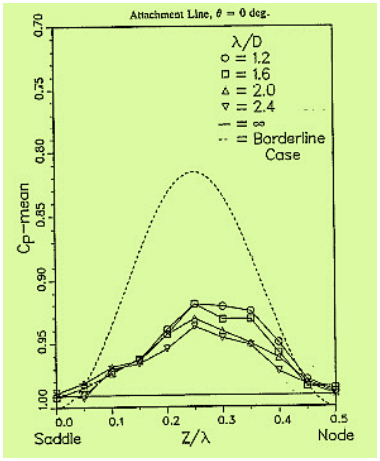


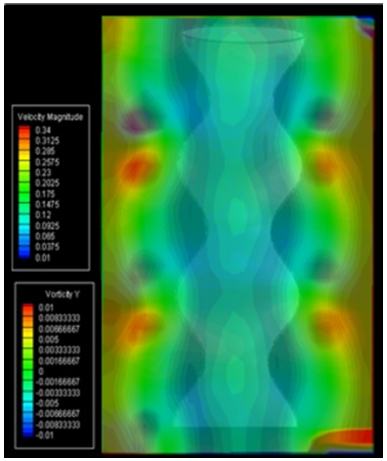


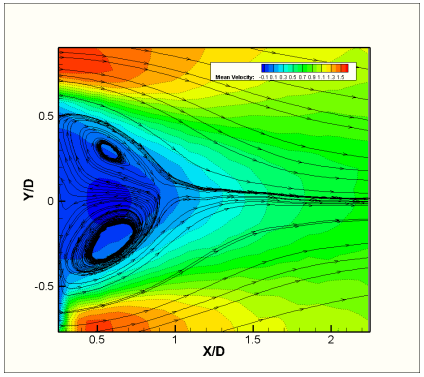
Experimental Investigation of Complex Vortex Dominated Flow

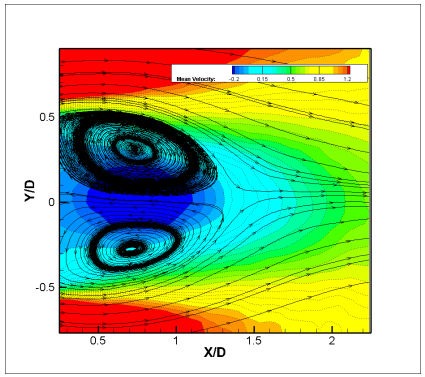
- Turbulent Mixing – Wake Flow of a Three Dimensional Wavy Cylinder Using Volumetric Particle Image Velocimetry, Proper Orthogonal Decomposition

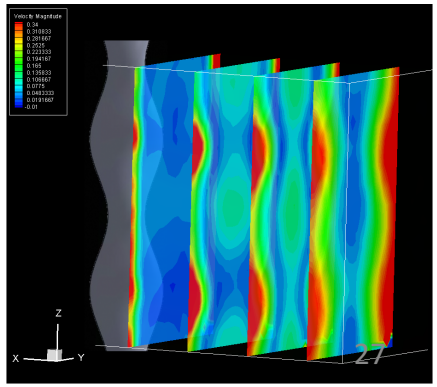












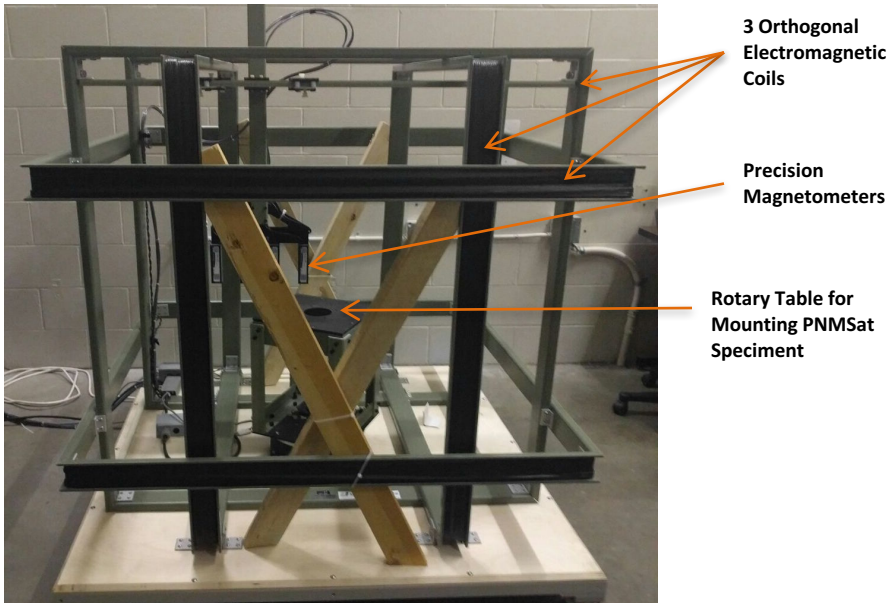
Characterization of Magnetic Field of Pico/Nano/Micro-Satellites to Facilitate "Magnetic Cleanliness"

❑ Introduction & Background

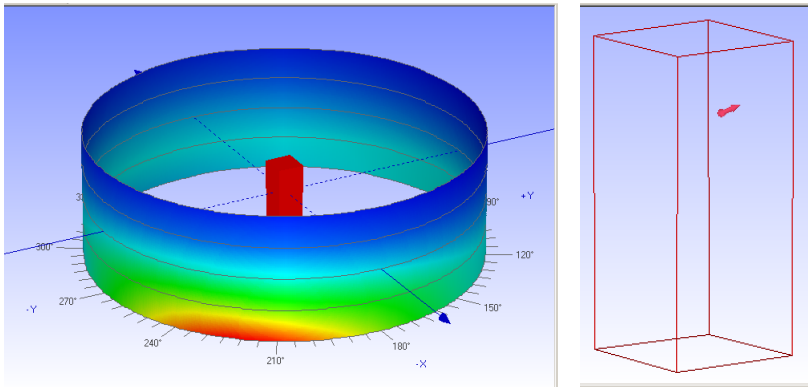
- Pico/Nano/Micro-satellites (PNMSats), particularly CubeSat class of satellites, are compactly packaged due to size, weight, & power (SWaP) constraints.
- The magnetic activity & bias within these satellites can affect the performance of magnetically sensitive sensors, actuators & instrumentation.

❑ Research Goals & Objectives

- Experimentally map the magnetic field of PNMSats in a Helmholtz Coil Cage.
- Develop a mathematical model (static & dynamic) of the magnetic map.
- Use the mathematical model to determine and cancel the magnetic bias at any position
- Facilitate Magnetic Cleanliness of PNMSats
- Refine attitude determination and control capability of PNMSats



Experimental Setup for Characterizing Magnetic Field Map of PNMSats



Preliminary Results of Determined Magnetic Map and Main Dipole

Research Capability: Chemical Engineering

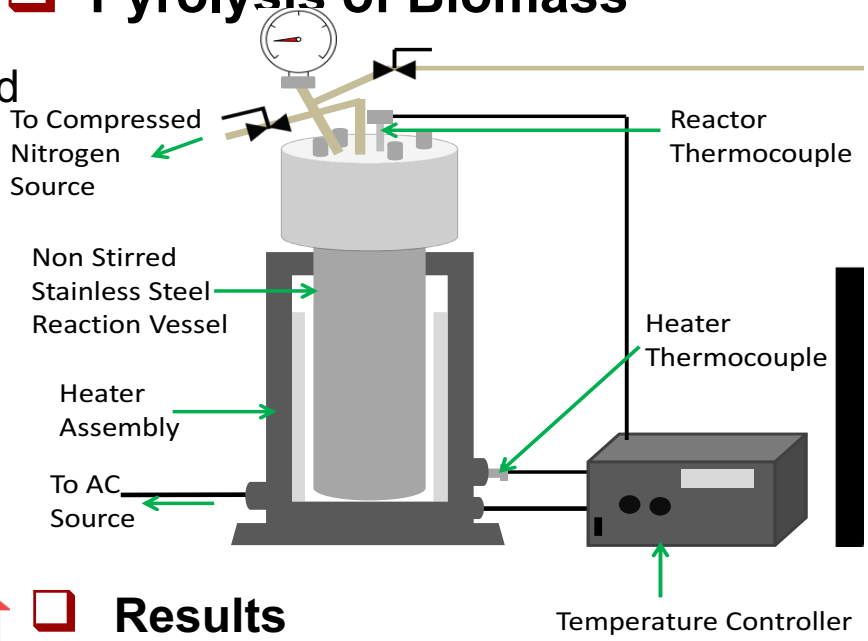
Biochar: CO_2 Sequestration and Soil Amendment

What is Biochar?

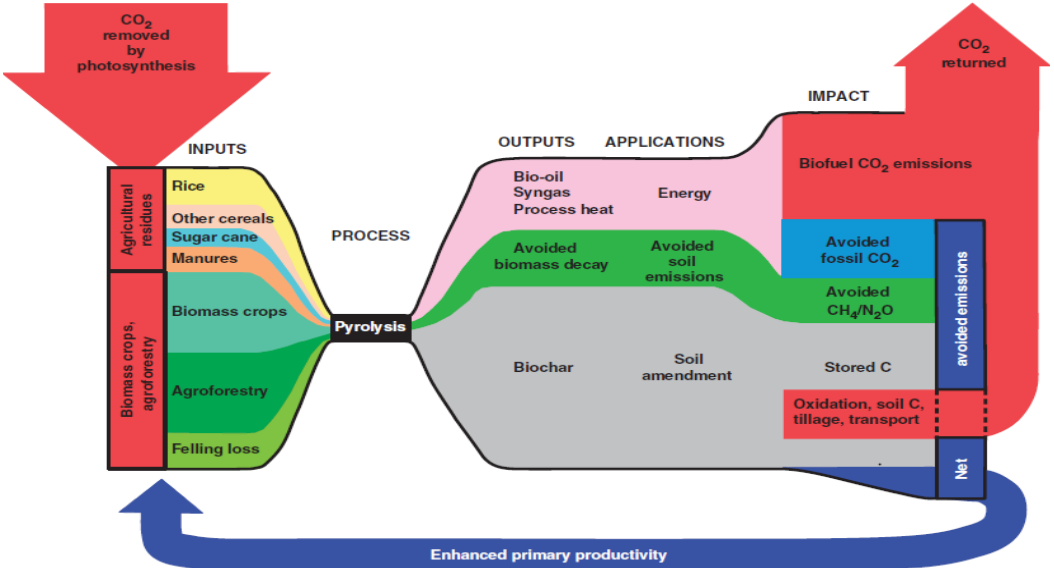
– Biochar is a stable recalcitrant carbon produced by thermal decomposition of biomass under oxygen-limited conditions (pyrolysis: <700 °C).

- Agricultural crop residues
- Forestry residues
- Municipal solid waste & Animal manures

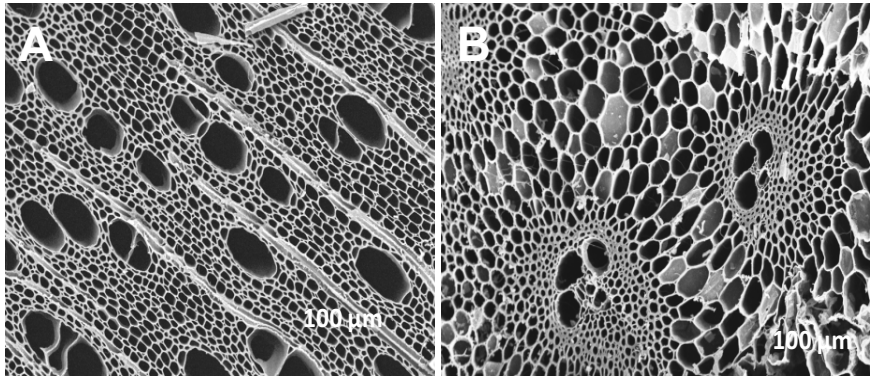
Pyrolysis of Biomass



Environmental Carbon Accounting



Results

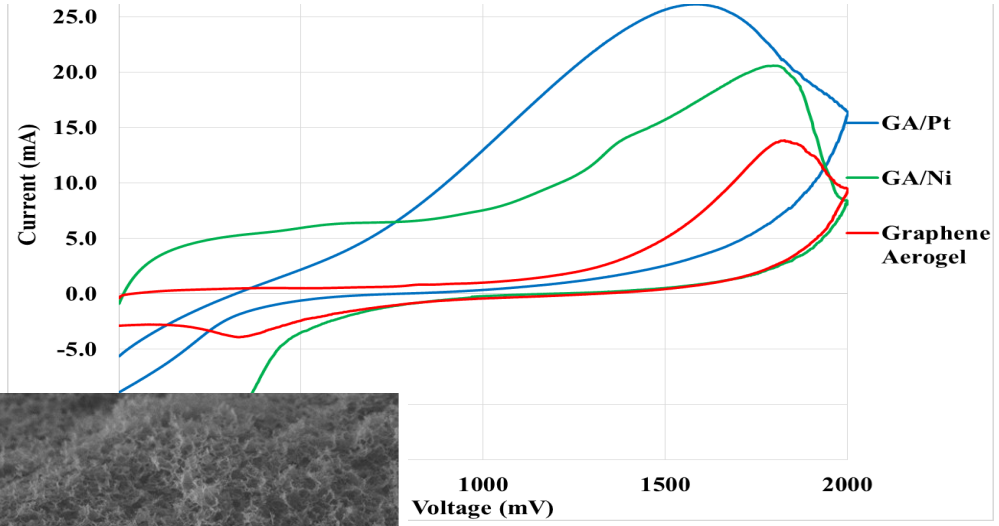


SEMs of highly porous biochar from wood shavings (A) and Sugarcane Bagasse (B)

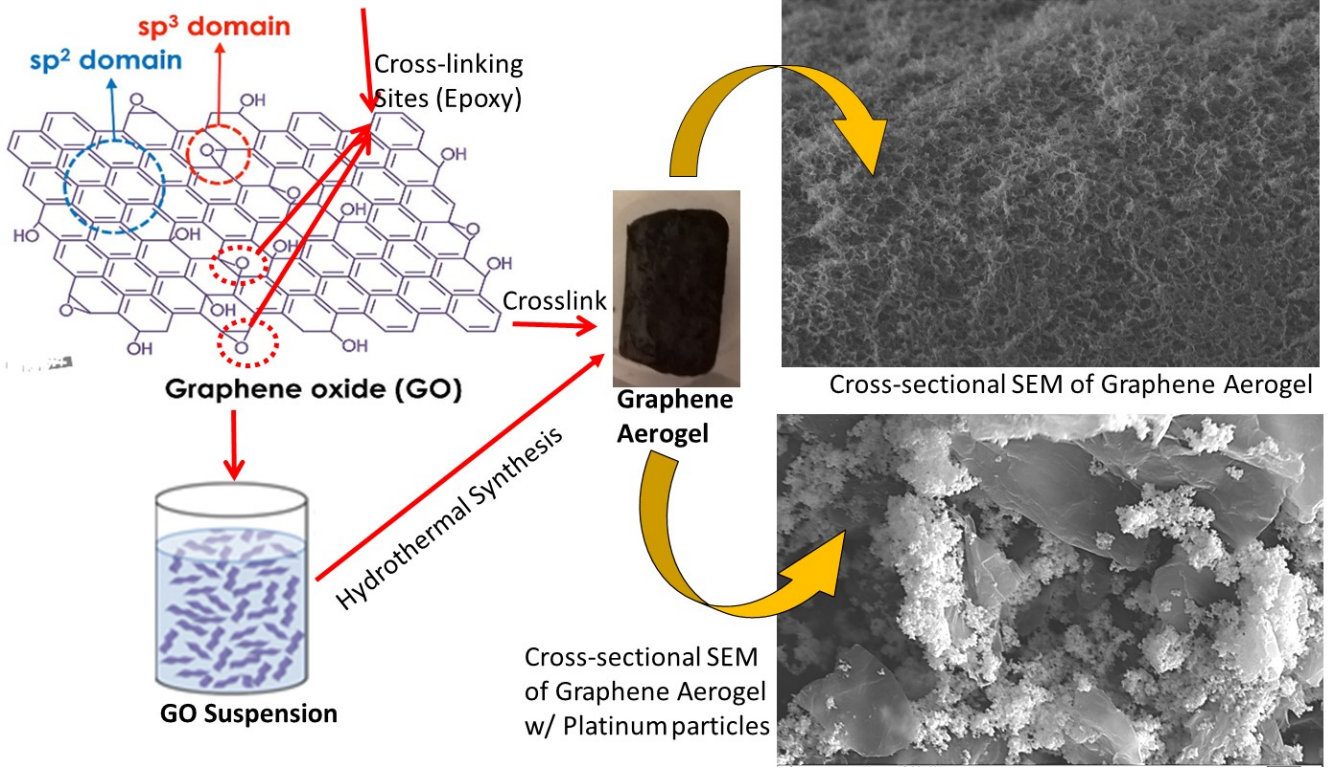
Synthesis & Electrochemical Characterization of Graphene/Metal Nanocomposites

Specific Objective

Synthesize graphene/metal and graphene/metal oxide nanocomposites Insitu with superior electrochemical properties



Hydrothermal Synthesis Protocol

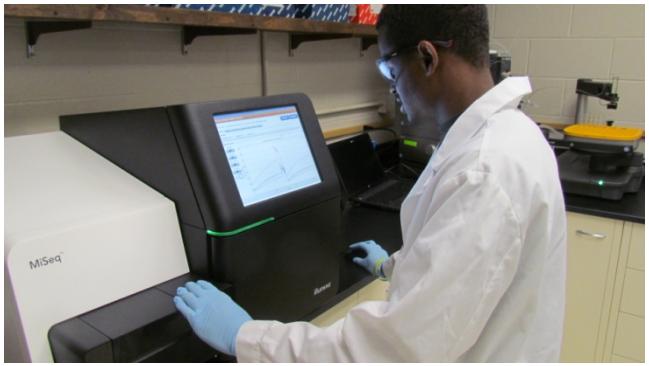


- Overlay Voltammogram of Graphene Aerogel composites in methanol oxidation. Pt-Graphene aerogel composite show superior electrochemical activity

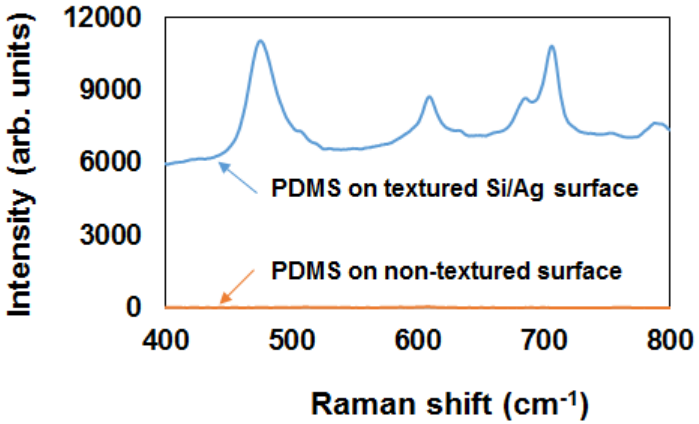
Research Capability: Electrical Engineering

Portable Smart Platforms for Detection of Biological Pathogens & Chemicals

- **Research:**
  - **New, sensitive portable technologies for detection of pathogens & other bio-chemical threats.**
- **Educational:**
  - **Educate and train students at TU in homeland security - STEM areas.**
  - **Research experience and curriculum development.**



Portable detection platform based on Raman spectroscopy



Sensitive detection possible

Funded by US Department of Homeland Security

Center for Ultra-wide-area Resilient Electric Energy Transmission Networks (CURENT)

CURENT is an Engineering Research Center headquartered at the University of Tennessee-Knoxville and is funded by the National Science Foundation (NSF) and the Department of Energy (DOE).

Research Focuses:

- Power systems
- Power electronics
- Data visualization
- Cyber security
- Electronic power conversion
- Smart grid technology
- Power markets
- Electric vehicles
- Energy harvesting

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